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ABSTRACT

One hundred and twenty kindergarten and second grade children from three different language environments were given a perceptual matching test and a verbal communication test to examine the relationship between language and cognitive performance. The object of the study was to focus on the cognitive processing demands imposed by the linguistic rule governing prenominal adjective ordering. The three language groups included 40 Mexican-Spanish speaking children from Monterrey, Mexico, 40 Chicano-Spanish speaking children, and 40 English speaking children from Houston, Texas. As expected, the English speaking group had significantly lower performance on the communication task than the two Spanish-speaking groups because of the processing demands imposed by English adjective ordering rules. The English-speakers also performed significantly lower on the perceptual task. Implications for education were discussed. (Author/AMH)

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English and Spanish-speaking Children's Performance on Perceptual and Communication Tasks: A Cross-cultural Study of Language and Cognition

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The relationship between language and thought has been a perennial subject of debate and study. Among developmental psychologists the debate stems from the differing perspectives of Piaget and Vygotsky. Briefly, Piaget feels that "language does not constitute the source of logic but is, on the contrary, structured by it" (Piaget and Inhelder, 1969, p. 90). For Vygotsky, however, language structures thought through an inner speech which is "to a large extent thinking in pure meanings" (Vygotsky, 1962, p. 149) and through an outer speech that provides verbal labels for forming scientific concepts.

The present investigation examined the relationship between language and cognition as influenced by the language environment. A position drawing upon both Piaget's and Vygotsky's perspectives was taken to explain this relationship. Specifically, it was assumed that at least during the period in which a language is being acquired, thought and language interact and, together, influence performance. This interaction was noted in an earlier study (Foorman, 1975) in which a child had to describe a wooden animal in terms of its relative attributes of size, color, substance, and shape so that an adult could locate the animal from an array of animals that included all logical combinations of attributes. When these attributes are mentioned prenominally (e.g., a big, brown, spotted dog) the relative position of each attribute is constrained by English adjective ordering rules. The order for these attributes is size first, then color, then substance, and, finally, shape. The utterance a spotted, brown, big dog sounds aberrant unless the pragmatics of the situation are unusual (e.g., "It is the spotted big, brown dog that bit the mailman.") Various reasons have been offered for the existence of such adjective ordering constraints (cf., Foorman, 1975; Richards, 1979), ranging from a linguistic emphasis on the syntactic notion of transformations or the semantic notion of classes to a psycholinguistic emphasis on informativeness.

The object of the present study was to focus on the cognitive processing

demands (i.e., demands on thought) imposed by this linguistic rule govering prenominal adjective ordering. During the period of acquisition of this rule Foorman (1975) found that demands on thought were sufficiently great that 5 year olds were able to coordinate on the average only two attributes within one utterance (e.g., "It's a brown dog."). By age 7 English speakers appeared to have acquired productive rules for prenominal adjective ordering and were able to coordinate all four attributes with relative ease; however, only a few 7 year olds were able to comprehend correct adjective orders.

In a language which does not have such prenominal adjective ordering constraints it was hypothesized that young children would not have as much difficulty coordinating attributes as the English speakers. Spanish is such a language. There is a preferred ordering of form, size, color, and substance (e.g., un perrito cafe con bolitas). But the ordering appears less rigid than English (e.g., un perro grande cafe con bolitas or un perrote cafe con bolitas) and the subsuming of the size attribute into the shape attribute (i.e., perro) by means of the suffix "-ito" or "-ote" seems to reduce demands on cognitive processing.

In order to examine the cognitive consequences of this linguistic rule concerning the ordering of prenominal adjectives in English, a study was designed which engaged English and Spanish-speaking 5, 6, and 7 year olds in a referential communication game and a perceptual matching task. The Spanish-speaking children included Mexican and Chicano samples so that differences in language environment rather than merely language per se could be addressed. The Chicano-Spanish speaking children were defined as children of Mexican descent who were born in the United States and were described by their bilingual education teachers as dominant in Spanish (and able to speak some English). They were included in the study to determine the extent to which contact with English adjective ordering rules and code-switching might

influence their Spanish-speaking performance. They also provided a control on the experiental aspect of schooling--a factor of potential importance in a cross-cultural study. Both the Chicano and Anglo children had been exposed to attribute games in their classrooms, while the Mexican children had not. In fact, very few 5 year olds in Mexico go to school. The Mexican 5 year olds in this study did attend school but their curriculum consisted of enrichment activities rather than readiness training.

METHOD

Subjects

The investigation involved 120 five, six, and seven year olds from Mexican-Spanish speaking, Chicano-Spanish speaking, and English speaking environments. The Chicano-Spanish and English groups were drawn from the same public elementary school in Houston, Texas. As mentioned earlier, the Chicano-Spanish speaking children were defined as American born and of Mexican descent and who were described by their teachers as dominant in Spanish. Monterrey, Mexico was selected as the site for the Mexican-Spanish speaking subjects because Monterrey is a large contributor to the Chicano-Spanish speaking population in Texas (Cornelius, 1968). The school for the children of the employees of Cuauhtemoc Brewery was selected in Monterrey because this school contained a kindergarten (whereas most public schools in Mexico do not) and served a population comparable in socio-economic status (i.e., lower-middle class) to the Houston sample. The average ages of the Mexican-Spanish speaking groups were 5;10 and 7;7. For the Chicano-Spanish speaking groups the average ages were 5;9 and 7;8, and for the English speaking groups the average ages were 5;9 and 7;9.

Procedure

Each child was individually tested in his/her native language by an adult female of the same language/cultural groups on a set of three tasks: Mr. Cucui,

a perceptual choice task, and a referential communication task. Mr. Cucui (Díaz, 1974), is a short term memory test in which the subject must remember the number of spots of color that appear on a picture of a potato man. The more spots of color, ranging from one to four, a subject can remember the greater the subject's short term memory and, hence, mental processing capacity. The typical range of scores demonstrated on Mr. Cucui (Pascual-Leone, 1969) for 5-6 and 7-8 year olds was used as a subject selection criterion for the three language groups.

The perceptual choice task (Toki, 1974, Note 1) is a perceptual matching game where children match three-dimensional wooden objects according to attributes of color, size, shape, and substance. There were five trials, each consisting of an array of four objects. The child is handed a stimulus object and asked to "find me one like this one." For instance, if the child is handed a small, yellow, stripped square, he/she may point to the first object in the array on the basis of size, the second object on the basis of stripes, the third object on the basis of shape, and the fourth object on the basis of color. Each child was encouraged to make an many matchings as possible.

In the referential communication task (Foorman, 1975) a child is asked to choose an animal from a group of wooden animals which vary on the attributes of shape (camel, dog), color (yellow, brown), size (large, small) and substance (stripes, spots). Knowledge of these attribute values was assessed pre-experimentally by showing the child a picture of each attribute and asking for a label or description. The game consisted of having the child select one wooden animal from the array of all possible combinations and putting it in a box while the experimenter hid her eyes. Then the child was asked to describe the chosen animal in terms of its relevant attributes so that the experimenter could try to find it in the array. If the child did not produce a description which enabled the experimenter to differentiate between the

chosen animal and the others in the array, then the experimenter elicited relevant attributes by selecting animals from the array which were consistent on the attributes mentioned but inconsistent on those not yet mentioned. Through this feedback process all four relevant attributes were elicited. At the end of each of the five trials the child was asked to "tell me again how that animal looks so that I can write it down." In this way the child had an opportunity to coordinate all four attributes. This final description was scored for its syntactic coordination on a 0 to 3 scale with intervals of one-half of a point.[2]

At the end of the referential communication task, English speaking children were given several orders of attributes from the game and asked which sounded "o.k." to them (i.e., spotted, brown, big dog). In this way, comprehension as well as production of attribute ordering was assessed.

Results

Analyses of variance with repeated measures were performed on the number of attributes matched in the perceptual task and in the communication task (before and after feedback) and on the number of steps of feedback in the communication task. Independent variables were language group, grade level, and trials. In addition to the ANOVAS, separate chi-squares for language group and for grade level were performed on the attribute orders demonstrated in the perceptual and communication tasks and on the syntactic coordination of the descriptions in the communication task. Moreover, correlations within language group were obtained for the dependent variables of the communication task and grade level. First, results on the communication task will be presented.

Insert Table 1 about here

Table 1 provides the means for the communication and perceptual task measures, broken down by language group and grade level. In the communication task there were significant language group differences in the number of relevant attributes produced in the initial encoding ($F_{2,114} = 131.18$, $p < .01$) and in the final encoding ($F_{2,114} = 32.11$, $p < .01$), and in the number of steps of feedback ($F_{2,114} = 44.87$, $p < .01$). Post-hoc analysis utilizing the Scheffé' statistic revealed the differences to be due to the superior performance of the Chicano-Spanish speakers in the analysis of initial encodings and in the analysis of steps of feedback and to the superior performance of both Spanish speaking groups in the analysis of final encodings. This final encoding analysis also revealed a significant main effect of grade level ($F_{1,114} = 12.65$, $p < .01$), favoring the second grade and an interaction of grade level with language group ($F_{2,114} = 4.25$, $p < .017$). Figure 1 reveals that for the English speaking group kindergartners and second graders were performing similarly, whereas for the Spanish speaking groups the second graders were outperforming the kindergartners.

Insert Figure 1 about here

Chi-square analyses were performed on the degree of syntactic coordination in the initial encodings and in the final encoding given after the experimenter asked the child to describe the animal again so that she could write down the description. There were significant language group differences in both analyses: $\chi^2 = 49.52$, $p < .00$ for the initial encoding analysis and $\chi^2 = 32.10$, $p < .00$ for the final encoding analysis. Table 2 gives the number of subjects in each language group whose syntactic coordination scores across the five trials were below the median and above the median.

Insert Table 2 about here

As can be seen by comparing language group performance within and across initial and final encodings, many more English speakers produced relatively uncoordinated encodings (both initially and finally) than either of the Spanish speaking groups. When the two Spanish speaking groups are compared an interesting shift can be noted across encodings: Initially many Chicano children produced relatively coordinated encodings, whereas the Mexican children were more evenly split in terms of their level of syntactic coordination. But in the final encoding the reverse pattern appears. Chicano children were evenly split and it is the Mexican children who were producing relatively greater syntactic coordination.

The significant relationships between syntactic coordination and language group revealed in the chi-square analysis was also supported by a correlational analysis. With Spanish speakers' scores combined, there were significant correlations between language group and syntactic coordination in initial encodings ($r = .49$, $p < .001$) and final encodings ($r = .48$, $p < .001$). Intercorrelations of communication task measures and grade level within each language group revealed two interesting points. First, for the Mexican group grade level was significantly correlated both with the number of attributes given in the final encoding ($r = .64$, $p < .001$) and with the level of syntactic coordination in the final encoding ($r = .55$, $p < .001$). Second, while the relationship between feedback and the syntactic coordination of final encodings was significant for the Spanish speaking groups ($r = -.43$, $p < .003$ for the Chicano and $r = -.40$, $p < .005$ for the Mexican group), the relationship was not significant for the English speaking group ($r = -.32$, $p > .01$). In other words, for the English speakers a reduced need for feedback did not

result in more coordinated final encodings, as it did for the Spanish speaking groups.

Analysis of variance on the number of attributes matched in the perceptual task revealed significant main effects of language group ($F_{2, 114} = 10.83$, $p < .01$) and trials ($F_{4, 456} = 7.10$, $p < .00$) and significant interactions of trial x language group ($F_{8, 456} = 3.47$, $p < .001$) and trial x grade level ($F_{4, 456} = 3.90$, $p < .01$). Post-hoc analysis utilizing the Scheffé' statistic showed the language group differences to be due to the greater number of matches made by both Spanish speaking groups. Figure 2 portrays the interactions of trials with grade level and with language group .

Insert Figure 2 about here

As Figure 2 clearly reveals, the trial x grade level interaction is due to the gradual improvement in performance across trials for the kindergartners compared to the slight decline in performance across the first three trials followed by improvement by the second grade. The trial x language group interaction reveals that the Spanish speaking groups improved performance across trials whereas the English speaking group did not.

Analysis of attribute orders in the perceptual and communication tasks focused on the first attribute matched or produced by each language group. Chi-square analysis of first-matched attributes in the perceptual task revealed significant language group differences ($\chi^2_6 = 14.20$, $p < .027$). The English speaking group predominantly chose shape first; the Chicano group chose color, shape, and substance; and the Mexican group chose color and substance. There were also significant language group differences in first-mentioned attributes in the communication task ($\chi^2_8 = 53.59$, $p < .01$) and these differed slightly from the order revealed in the perceptual task. In the communication task

color was the most frequent first attribute for the English group, whereas shape was the most frequent for both Spanish speaking groups.

The results of the scrambled attribute orders given to the English-speaking subjects were insignificant. Only one subject out of 40 comprehended incorrect and correct ordering. Although the analyses presented above do suggest that the English children had difficulty producing correct attribute orders, it is perhaps unfair to conclude from this one test that they also have difficulty comprehending them. The nature of the task instructions was probably too difficult for children of this age group.

Discussion

It was the intention of this investigation to draw attention to the fact that at certain periods in language acquisition the processing demands imposed by linguistic rules may inhibit cognitive performance. With processing capacity controlled across language groups by performance on Mr. Cucui, this intention was clearly demonstrated by the relatively poor performance of the English speaking children in the communication task. English speakers (in both kindergarten and second grade) produced significantly less relevant attributes in final encodings after all relevant attributes had been elicited than both groups of Spanish speakers. Moreover, English speakers produced significantly less relevant attributes in initial encodings and required significantly more feedback than the Chicano speakers. The degree of syntactic coordination in initial and final encodings was also significantly less for English speakers than for Spanish speakers.

Language group differences favoring the Spanish speakers also were demonstrated on the perceptual task, where constraints on performance imposed by English adjective ordering rules would seem less obvious. But, upon reflection, it is not surprising that a language mediation strategy might be employed in coding perceptual matches and that, therefore, adjective ordering rules might

influence performance.

The implications of this study for school performance are important. Teachers often expect children to respond to cognitive tasks similarly, despite the type of task or language spoken by the child. But, plainly, the availability or unavailability of an appropriate information-packaging rule in the child's language may spell comparative success or failure in the cognitive task at hand. The prenominal adjective ordering rule in English provides a way for adult speakers to coordinate four attributes within one utterance--the kind of linguistic demands imposed by the communication task and, to a lesser extent, by the perceptual task. Acquisition of this rule was not demonstrated by the English speaking children in this study, even by age seven. Further research is needed to reveal the age at which use of the prenominal adjective ordering rule is achieved in English speakers and further cross-cultural work is needed to map the differential effects of languages on children's ability to perform cognitive tasks.

Reference Notes

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Footnotes

1. The one exception to this format was with the perceptual task for the Chicano-Spanish speakers. Due to the lack of time remaining in the school year the testing was conducted by the Mexican experimenter rather than by the Mexican-American experimenter. Actually this inconsistency was good because possibilities of experimenter bias were thereby reduced. Experimenter bias is always a potential criticism of cross-cultural research. But the importance of having an experimenter who shares the language and cultural background of the children with whom she is communicating cannot be underestimated. Given more money to hire experimenters, one solution to this problem is, of course, to build the experimenter in as a variable in the study.

2. The coding scheme for scoring the syntactic coordination of final descriptions was based on the following criteria (and an inter-rater reliability coefficient of .92 was obtained on the Anglo, Mexican, and Chicano experimenters' use of these criteria):

   0 points: No relevant attributes or only 1. (E.g., "a dog." "Es un animalito.")

   .5 points: 2 relevant attributes conjoined merely by the word "and" or by two verbs or by "and" + Verb. (e.g., "un camello y es amarillo")

   1 point : 2 relevant attributes which are comjoined by Verb + "and" or gramatically acceptable compacting (e.g., "perrito" or "A camel with spots").

   1.5 points: 3 relevant attributes which are conjoined by the word "and" or by more than one verb, or by a medial verb (e.g., "un perrito con rayas y es amarillo").

2 points: 3 relevant attributes which are conjoined by gramatically acceptable compacting (e.g., "A big, brown dog "or" un camello amarillo con bolitas").

2.5 points: 4 relevant attributes which are conjoined by the word "and" or by more than one verb or by a medial verb (e.g., "It's a little brown dog and it has stripes").

3 points: 4 relevant attributes which are conjoined by gramatically acceptable compacting (e.g., "A big, brown, striped dog," "un perro grande cafe con rayas").

Table 1

Table of Means for Communication and Perceptual Task Measures

Broken Down by Language Group and Grade Level

		Language Groups					
		English		Chicano		Mexican	
Dependent Variable		K	2	K	2	K	2
Communication Task							
# Rel. Attrib, in initial encoding		1.97	2.16	3.12	3.24	1.48	1.73
	T	2.06		3.18		1.60	
# Rel. Attrib. in final encoding		1.91	1.96	2.89	3.24	2.44	3.36
	T	1.93		3.07		2.90	
# Steps of feedback		1.86	1.52	.82	.70	2.03	1.76
	T	1.69		.76		1.90	
Perceptual Task							
#Rel. Attrib. matched		2.10	2.23	2.50	2.85	2.79	2.99
	T	2.12		2.68		2.89	

Note.- Language Group was significant in:

# of relevant attributes produced in the communication task for (1) initial encodings ($F_{2, 114} = 131.18$, $p < .01$); (2) final encodings ($F_{2, 114} = 32.11$, $p < .01$); and (3) steps of feedback ($F_{2, 114} = 44.87$, $p < .01$).

# of relevant attributes matched in the perceptual task ($F_{2, 114} = 10.83$, $p < .01$).

Grade level was significant in # of relevant attributes produced in final encodings ($F_{1, 114} = 12.65$, $p < .01$) and in an interaction with Language Group for this same analysis ($F_{2, 114} = 4.25$, $p < .017$).

Table 2

Number of Subjects in each Language Group Producing High and Low Levels of Syntactic Coordination in Encodings

Language Groups

		English	Chicano	Mexican	
Level of syntactic coordination in initial encodings	1	33	2	22	57
	2	7	38	18	63
		40	40	40	Totals

Note.- $\chi^2_2 = 49.52$, $p < .01$

		English	Chicano	Mexican	
Level of syntactic coordination in final encodings	1	33	17	8	58
	2	7	23	32	62
		40	40	40	Totals

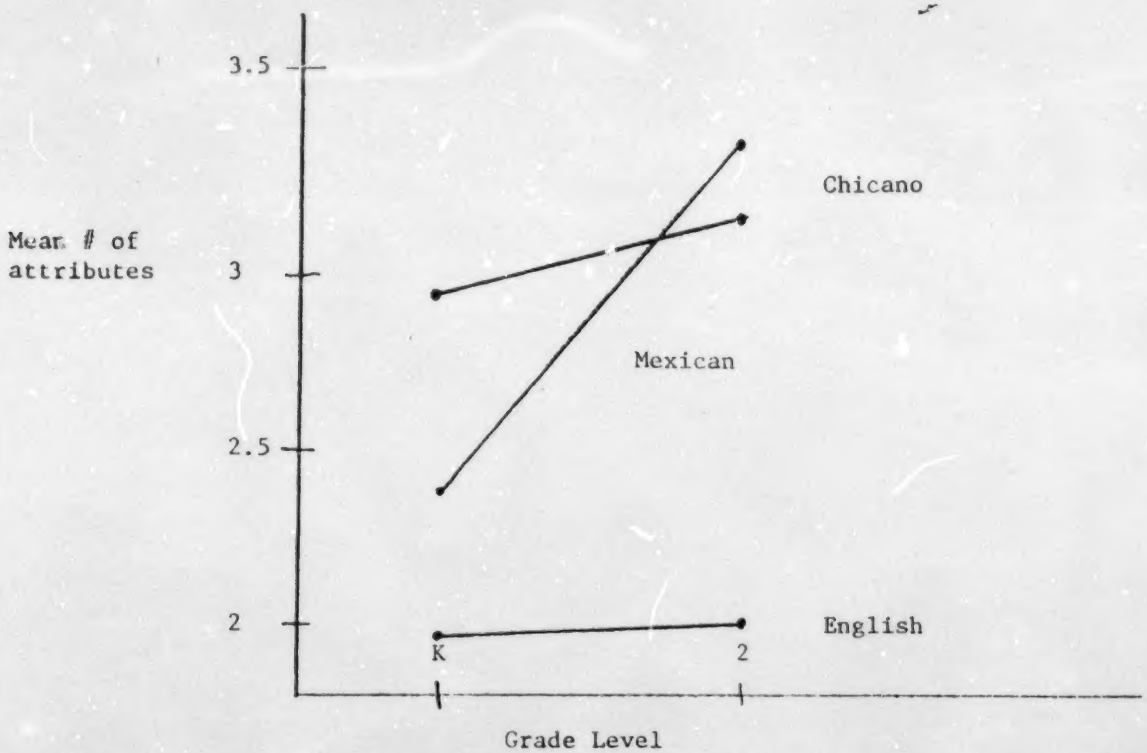
Note.- $\chi^2_2 = 32.10$, $p < .01$

Note.- Syntactic coordination scores across five trials have been dichotomized around the median and represented here as high (#2) or low (#1).

Figure 1

Mean Number of Relevant Attributes Produced in

Final Encodings by the Three Language Groups at Two Grade Levels



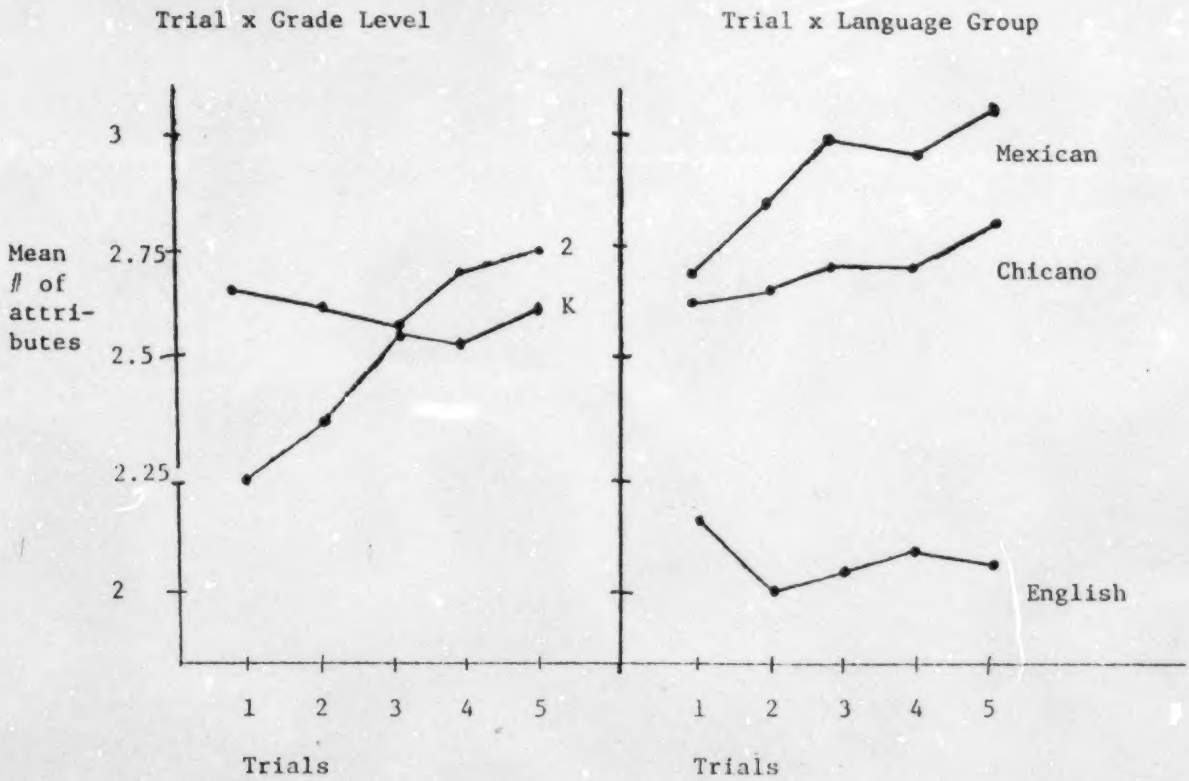
Note.- Language Group x Grade Level is significant at

$F_{2,\ 114} = 4.25,\ p < .017.$

Figure 2

Interactions of Trials x Grade Level

and Trials x Language Group in the Perceptual Task



Note.- Trials x Grade Level is significant at $F_{8, 456} = 3.90$ $p < .01$ and Trials x Language Group is significant at $F_{8, 456} = 3.47$, $p < .001$.